Integrated Road Maps Route the Migration to Avionics Open Systems

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CrossTalk

The Viable Combat Avionics (VCA) initiative was developed to combat aging avionics, including diminishing manufacturing sources and out-of-production parts, and to create more affordable avionics by making it easier to insert new technology and operational capabilities into systems. An integral part of the initiative is the development of integrated change road maps to guide the migration of avionics architectures to a state that enables their viability to be continued. David G. "Butch" Ardis, technical adviser for avionics systems architecture, was tapped to provide technical leadership to the VCA initiative, responsible as chief avionics architect for the aeronautical domain.

Lt. Col. Glenn A. Palmer, program director, Computer Resources Support Improvement Program, and Pamela Bowers, CrossTalk *managing editor, met with Ardis at Wright-Patterson Air Force Base to discuss these avionics road maps. Ardis is a Senior Level executive at the Aeronautical Systems Center (ASC).*

Ardis began his federal service career as an officer in the Air Force. His military service included two combat tours in Southeast Asia, a teaching assignment at the Air Force Electronic Warfare Officer Training School, and a tour in project engineering at Aeronautical Systems Center. His civilian service includes assignments as technical expert for mission avionics and technical director for avionics engineering at ASC.

Q: As the person working directly to implement avionics modernization, what is your architecture template for change?

Ardis: Our change template for modernization as well as other avionics changes is centered around the Viable Combat Avionics (VCA) initiative. Aging avionics issues, avionics affordability issues, and viability issues depending on specifics, all refer to the same general VCA concepts. Affordably dealing with the changes that are occurring is a combination problem: 85 percent business and 15 percent technical. Business challenges include affordability and obsolescence. Technically, the challenge is to begin using the open-systems principles that will facilitate affordably changing our avionics systems; that is what I have been tasked to do. The technical side starts with using open-systems principles.

The term *open systems* is a multi-headed animal with lots of different definitions. Our first step in applying open-system principles is to get rid of ambiguity and say what it is we want from open systems. The *what we want* then needs to be put into performance terms that actually can be measured. Then when we put those terms into our contracts, we'll start seeing the benefits of applying open-systems principles.

When we talk about applying open-systems principles, we are talking about finding ways to affordably do the things we need to do when we change our avionics. Changes include reliability improvement, obsolescence mitigation, periodic software updates, adding new capabilities, etc. We also need new systems that are affordable to change.

Second, most of our systems are so costly that in most cases any strategy must be incremental or evolutionary in nature. We have to take advantage of the funds that will be available such as those for operational capability improvements.

Third, since we have to make big platform changes, and it must be done incrementally, a strategic context needs to be developed to determine what to put into the current contract vs. contracts years down the road. That was how the idea of making integrated change road maps came about.

Early on, mentioning affordable avionics was met with resistance. The system program directors were skeptical and saw this as a plan to cut their already lean budget. We had to explain that we were not there to advocate taking away their money. Rather, we were trying to get the greatest benefit for every dollar our operational customer spent.

We believe it will be possible to improve the efficiency and effectiveness of the funds invested if we can cut back on the amount of money we spend on diminishing manufacturing sources (DMS), obsolete parts, verification, etc., and can reduce cycle time.

Q: What functions do the avionics road maps serve?

Ardis: The real objective of the avionics change road maps is to set the strategic context for the system. To construct road maps, we began by asking program managers to do an avionics health-assessment based on the affordability of their programs. Is the design producible? That doesn't mean that the configuration won't change during production, but how much pain is associated with any needed changes? Is the design supportable and *growable*? We're asking them to look at their architecture and its implementation right now and then look at the changes operational customers are proposing. What can we do to the architecture to migrate it to a more desirable state?

Once the desired result is defined, the operational capability updates serve as a target of opportunity for shifting and evolving the architecture advancements and affordability.

The basic assumption is that if we cannot get money that is just for the basic architecture changes, then deliver the funded required capabilities changes in a way that mitigates the affordability issues we're having. I'm hopeful that if people think along these lines, as they lay out the planning process to add capabilities, they automatically start thinking about how to migrate architecture with that plan. Given budget constraints, that's the best we can do in terms of migrating to more affordable platforms.

Q: In what role do you see the Air Force Research Laboratory in avionics-related technologies in the next five to six years?

Ardis: Obviously this is Butch Ardis' opinion. There are many technology opportunities for Air Force Research Laboratory (AFRL) investment. Instead of the normal technology discussions, let's restrict this to some thoughts about things that will help us achieve the objectives of more effectively and efficiently dealing with the future viability of our avionics.

Reducing the costs of verification of modern high performance avionics is an area that needs much attention. Our avionics systems are continually undergoing changes with the attendant verification requirements. The highly integrated nature of many of our systems demands that more and more resources be used on verification – especially safety critical applications.

We have some major technical concerns in some of our architecture proposals and difficulty in verifying their performance. This is an opportunity for the labs to help. As we go to these highly integrated, high performance avionics systems it becomes necessary to develop and qualify approaches that reduce the verification resource burden. There are at least two areas for consideration. First, we need to make ease of verification a performance consideration. Avionics system architectures as well as hardware and software architecture developments need to put more emphasis on reducing verification costs. I believe the labs can help us with developing architectures that are easier to test.

Second is the verification processes themselves. The F-22 is an example. It has unprecedented abilities to engage many targets in a beyond visual range environment. Flight testing of its most stressing performance requirements takes many more resources than previous aircraft to support some of the test conditions. We must do as much as possible on the ground to make our flight tests as effective and efficient as possible – you do not want to *debug* in the air. However, the development of ground-based simulations and support tools for verification also takes tremendous resources. To effectively do hardware-in-the-loop testing of the F-22's avionics approach on the ground requires a high fidelity stimulation that captures the relative movements of all objects that the avionics senses and injects signals with the proper time and kinematic characteristics into the front end of the sensors. We really haven't dealt with that level of fidelity requirements before, and it takes a large investment.

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Another verification area we could use help with is streamlining certification of architectures where we are doing multitasking and mixing levels of criticality in safety. We have to get the promised *lean* processes qualified. If we're going to cut program costs by reducing testing, then we've got to demonstrate that the underlying fundamental processes are valid. AFRL could help us develop these processes. Otherwise, if we have not *qualified* our verification processes and have to use traditional safety certification processes, we potentially have years worth of testing every time we update software in these mixed criticality, heavily loaded processors.

Agreeably, we need to do a better job of making sure the labs understand what we're trying to do with avionics in the future.

Q: What do you see down the road?

Ardis: Our biggest challenge is coming to grips with what the probable future is for avionics. I believe the objectives of Joint Vision 2020 and the implications of making our avionics systems effectively fit into a systems-of-systems operating concept will represent a major task for many of our legacy and new platforms. There is a lot of thought going into airborne and space-borne sensors that support generating timely information. Communication links are being put in so people can tap into the information. What we have not done adequately is look at how to take advantage of that information inside the cockpit. And what are we are going to do with it once we get that information to the pilot? This will drive future avionics architecture requirements.

For example when we upgrade displays, we are trying to push our programs to think aggressively about what is most likely to be done with these platforms in the systems-of-systems operations when we have that type of real-time information available in the airplane. There are going to be some very big changes required in onboard avionics. There will be too much information for the pilot to personally filter through everything. It must be automated.

This is another area where the AFRL can help us. How do you go about changing avionics from what truly is network centric as opposed to platform centric? It is a completely different approach to the way we want to do things. I don't think that very many of our platforms have avionics that are going to be compatible. So as we evolve our architectures, I think implementing systems-of-systems requirements and achieving interoperability will drive big changes in avionics architectures and their implementations. This will be especially difficult due to the costs associated with large avionics changes.

We have the technology challenges associated with obsolescence, DMS, processors rapid change, etc., but avionics performance requirements are going to be a real shock when we finally step up to implementing the systems-of-systems requirements.

As for other challenges, road-mapping a major activity is frustrating because we can't show the operational customers solutions that have saved them billions of dollars, yet. We are hopeful that down the road, customers will start seeing the benefits of the performance attributes associated with applying open systems.

A performance-based approach is key to where we are trying to push things. Just specifying open systems alone is not sufficient. We are trying to put things in the contracts that will give us the benefit of open-systems approaches – the major benefits being ease of change and verification of changes.◆